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ABSTRACT

This report summarizes advances in the understanding of Alzheimer's disease, the major cause of mental disability among older Americans. The demography of the disease is discussed, noting that approximately 2.5 million American adults are afflicted with the disease and that the large increase in the number of Alzheimer's disease patients is due to the growth in numbers of older people, a better approach to diagnosis, better training of health care professionals regarding the problems of old age, and the public's awareness of Alzheimer's disease. A cost estimate of $35 billion for the care of Alzheimer's disease patients is given. Research advances in diagnosis of Alzheimer's disease are reviewed, including advances using magnetic resonance imaging, and a test for a protein in the blood of victims. Biological mechanisms of the disease including differences in healthy and diseased brains and changes in brain chemistry are discussed. Theories about the cause of Alzheimer's disease are reviewed, including an examination of the role of aluminum, infectious agents, and genes as well as risk factors for the disease. Assessment and treatment approaches are summarized. The report concludes with future research directions. (ABL)

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PROGRESS REPORT ON ALZHEIMER DISEASE: Volume III

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Introduction

We know many things about Alzheimer disease that we didn't know a decade ago. More physicians know it when they see it; they even know how to treat some of its less serious symptoms, but they don't know how to stop it from getting worse or how to cure it. Scientists know more about what goes on inside the brains and bodies of people who have it, but they still don't know what causes it. Policymakers know that more and more people have it, that the numbers are likely to increase as life expectancy increases, and that the cost of their care could bankrupt a small nation in the years to come if nothing is done about it. Victims and their relatives now know better where they can go for help, but most cannot afford the cost of care. And the general public knows it exists . . . which is more than they knew a decade ago.

This report is intended to summarize advances in our understanding of the major cause of mental disability among older Americans.

Demography

By most estimates, Alzheimer disease is the cause of serious confusion and forgetfulness in some 2.5 million American adults. This is five times the estimate that appeared in the literature 10 years ago when the National Institute on Aging (NIA) began its first studies in this area. Are there so many more victims now than then? Is there an Alzheimer epidemic?

Because aging is the principal risk factor associated with Alzheimer disease, the number of Alzheimer patients is growing at least as fast as the U.S. older population. But these latest estimates stand for more than just growing numbers of older people. They reflect a more sophisticated, if not yet perfected, approach to diagnosis; better training of health care professionals regarding the problems of old age; and the general public's greater awareness of Alzheimer disease and its symptoms.

According to NIA-supported experts at Harvard University, our current estimates of the number of people with Alzheimer disease may still be too conservative. Dr. Denis Evans and his colleagues at the East Boston Neighborhood Health Center have examined the residents of that Boston community and have found that more than 11 percent of the population over age 65 may be suffering from Alzheimer disease. This is double the frequently stated estimates.

When this study has been completed and verified by other studies, and diagnostic capabilities are further refined, we may be surprised to learn how many people are suffering from Alzheimer disease and are being quietly cared for by relatives and friends.

The Cost of Alzheimer Disease

According to the Alzheimer's Disease and Related Disorders Association, $35 billion was spent last year on the care of Alzheimer patients. This includes the costs of nursing home and other long-term medical care, but doesn't begin to account for the emotional and social costs of the disease.

NIA health economist Dr. William Cartwright has tallied some of the specific costs of Alzheimer disease, suggesting that $35 billion is just the tip of the iceberg. Dr. Cartwright and his colleagues, Dr. Lien-Fu Huang of Howard University in Washington, D.C., and Dr. Teh-wei Hu of Pennsylvania State University in State College, estimate

that the special services required by dementia patients might cost more than $38 billion, with another $39 billion for what the investigators call indirect costs.

The investigators looked at how much money is spent on longer hospital stays, increased need for drugs, greater demands on staff time in nursing homes, special social services and other needs. A large portion of the cost of dementia—$27 billion—reflects the value of the time spent by relatives who care for Alzheimer patients at home.

This is the first time that anyone has calculated the costs of dementia. It is also the first time that anyone has put a value on the so-called "incalculable costs" of the disease. The $39 billion for indirect costs represents the investigators' estimate of the cost of relatives visiting patients in nursing homes, transporting patients for needed medical services, and premature death due to dementia. Dr. Cartwright cautions that these estimates may seem conservative because they include only the extra costs of medical care, rather than all the costs of medical care, for dementia patients.

Diagnosis

There is no single medical test that can diagnose Alzheimer disease. The early symptoms of Alzheimer disease—forgetfulness, confusion, changes in mood and behavior—are also symptoms of a large number of other conditions. As a result, physicians who suspect Alzheimer disease use a variety of tests, including medical history, clinical examination, blood and other laboratory tests, psychological tests and radiologic scans. The diagnosis of Alzheimer disease is made only after all other possibilities have been excluded.

Nonetheless, we are better able to diagnose Alzheimer disease today than ever before. Physicians are more attuned to the various disorders that can mimic Alzheimer disease, and are more likely to detect them during medical examinations. Newer psychological tests have begun to focus more closely on the early and progressive signs of Alzheimer disease. And now, recent developments in radiology have provided diagnostic tools that can better visualize the working human brain.

At the Massachusetts General Hospital in Boston, NIA grantee Dr. John Growdon and his colleagues are using magnetic resonance imaging (MRI), a recently developed diagnostic tool, to examine patients with Alzheimer disease and other forms of dementia. For an MRI scan, the patient is positioned inside a magnetic field crossed by radio frequency waves. The magnetic field causes the body's abundant supply of hydrogen atoms (which are positively charged) to come into alignment; the radio waves then deflect them out of alignment. When the waves are turned off, computers measure the energy emitted as the atoms realign within the magnetic field. By a complex system of calculations, information is then generated on the concentration of matter as well as certain physical and chemical properties.

The technique is safe and painless. In some cases, MRI brain scans may even be superior to CT scans in that the images are crisper, they differentiate between white and grey matter and they can visualize deep areas of the brain not seen in CT scans. Because MRI can more accurately pinpoint tumors and other intracranial disorders, the scans are extremely useful to physicians in diagnosing patients' problems.

Dr. Growdon and his colleagues have found that the unique ability of MRI to distinguish the brain's white and grey matter allows it to pick up abnormalities that may indicate early multi-infarct dementia, or MID (dementia caused by a series of small strokes). MID is the second leading cause of dementia in older people and is frequently

confused with Alzheimer disease because of similar symptoms.

Whether MRI will be a valuable diagnostic tool for Alzheimer disease is difficult to predict since this technology is still in its infancy. In the meantime, however, Dr. Growdon and his colleagues are excited by their findings of white matter lesions in people who show no other sign of disease. If this is, indeed, an early indication of multi-infarct disease, diet and lifestyle changes may prevent further damage.

As this research progresses, Dr. Growdon will be looking at those areas of the brain known to be affected in Alzheimer disease to see if changes in brain structure can be linked to changes in function as the disease progresses.

A Blood Test for Alzheimer Disease?

While MRI might eventually prove useful in differential diagnosis, a number of studies are holding out the hope of a simple diagnostic test for Alzheimer disease. Anatomically, Alzheimer disease is characterized by neurofibrillary tangles and neuritic plaques, as well as by deposits of amyloid fibers in the brain's blood supply. Dr. George Glenner at the University of California, San Diego has isolated and analyzed the amyloid fibers circulating in the bloodstream of Alzheimer patients and found a unique protein not seen in healthy individuals. Interestingly, the same protein appears in the amyloid deposits of Down syndrome, representing a link between Alzheimer and Down syndrome. With NIA support, Dr. Glenner next plans to use monoclonal antibodies to take a closer look at this unique protein with the hope of isolating its precursor.

This is one of several studies looking at proteins that can be linked to what takes place in an Alzheimer patient's brain as nerve cells begin to die. In studies at the Albert Einstein College of Medicine in the Bronx, New York, scientists have discovered an abnormal protein which they say is found only in the brains of Alzheimer patients, and only in those parts of the brain that are most severely affected by the disease. At Brigham and Women's Hospital in Boston, Massachusetts and the New York State Institute for Basic Research in Staten Island, other scientists have found that a normal protein is somehow altered during the course of Alzheimer disease, and speculate that this may play a role in the death of nerve cells. If scientists can find these same proteins or related proteins in the bloodstream or in some other body fluid, we may soon have a simple diagnostic test for Alzheimer disease.

Biological Mechanisms

In a series of investigations supported by the NIA, Drs. Charles Marotta and Elizabeth Sajdel-Sulkowska of Harvard Medical School and McLean Hospital in Belmont, Massachusetts have found a biochemical abnormality that impedes production of new protein in Alzheimer brain tissue.

For some time we have known that the most serious symptoms of the disease are closely correlated with the intracellular accumulation of abnormal protein structures called neurofibrillary tangles. But scientists have always been puzzled as to how these pathological changes relate to normal cell function.

Drs. Marotta and Sajdel-Sulkowska compared autopsied tissue from the cortex of six Alzheimer patients with that from four patients of the same ages who died of other causes. In the diseased brains, the investigators found massive accumulations of neurofibrillary tangles and little more than half the normal amounts of ribonucleic acid (RNA). RNA is a key chemical in the production of protein, a process that is critical to the life of the cell. A closer look linked the lower levels of RNA to the presence of increased ribonuclease activity. In the healthy brain, ribonuclease breaks down RNA, but its activity is closely controlled by an inhibitor protein. In the Alzheimer brain, Drs. Marotta and Sajdel-Sulkowska found that ribonuclease activity was higher, resulting in more destruction of vitally important RNA which results in less protein synthesis.

This work is an extension of earlier studies in which Dr. Marotta and his colleagues first showed that messenger RNA can be removed from the postmortem brain for scientific study. Until Dr. Marotta's pioneering work, it had been assumed that large molecules such as RNA and deoxyribonucleic acid (DNA) were broken down very quickly after death. This might have been the case using more traditional chemical methods for storing brain tissue. Formalin, the chemical used to fix brain tissue after death, destroys enzymes and other fragile biochemical substances in the autopsied brain. But most of these problems are alleviated when autopsied brain tissue is frozen and later thawed for study. According to Dr. Marotta, if the brain has been frozen and stored, RNA will synthesize protein as if in a living brain, even years after death.

As the investigators are quick to point out, their work on autopsied brain tissue has already been corroborated in living patients. Using positron emission tomography, a noninvasive technique which

monitors metabolic activity in living brain tissue, a group of French scientists has found a 65 percent drop in brain protein synthesis in patients in the later stages of Alzheimer disease.

It is not possible to state if this change marks the onset of Alzheimer disease, or if it is just one of a series of events that takes place as brain cells begin to die. If, as the investigators speculate, decreased protein synthesis results in the chemical changes and brain cell death characteristic of Alzheimer disease, then we might be one step closer to finding out what causes this debilitating illness.

Changes in Brain Chemistry

In addition to the accumulation of neurofibrillary tangles in the Alzheimer brain, another hallmark of the disease is a disruption of one of the brain's chemical messenger systems, the cholinergic system. With support from the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS), Dr. Joseph Coyle and his colleagues at The Johns Hopkins University in Baltimore, Maryland, have shown that one message pathway in the cholinergic system that deteriorates in the brains of Alzheimer patients also is destroyed in a rat model. This discovery might help explain why the brain's cortex and hippocampus, which lie at the end of this pathway, accumulate tangles and plaques, and why Alzheimer patients lose short-term memory governed by the cholinergic system but retain the long-term memory maintained by other chemical messenger systems.

Dr. Coyle has simulated cholinergic system deterioration in rats using a chemical that damages only cholinergic neurons. His study suggests that memory loss in the rat model of Alzheimer disease may be reversible: animals with induced cholinergic damage eventually regained some of their short-term memory.

In yet another study, NIA/NINCDS grantee Dr. Marek-Marsel Mesulam and his colleagues at Beth Israel Hospital in Boston, Massachusetts, have identified a distinct group of cholinergic neurons extending from the basal forebrain along cholinergic pathways and linking selected neurons in the basal forebrain with particular regions in the cortex. The investigators previously had demonstrated that changes in such cell groups can trigger the kind of brain dysfunction associated with Alzheimer disease. Studies of the newly discovered cell group show that these cells influence a region of the brain that transmits visual and other sensory information.

The Search for a Cause

The theories of what causes Alzheimer disease have matured in a rich atmosphere of research focused on the neuroscience of aging. The basic theories have not changed. Scientists still think that genetic factors; immunologic changes; unconventional virus-like agents; and environmental factors may all play a role in the development of Alzheimer disease. Nonetheless, more basic answers are being sought as to what causes the disease. NIA-supported scientists are examining the fundamental processes that underlie changes that take place in the brains of patients with Alzheimer disease.

At the Burke Rehabilitation Center in White Plains, New York, NIA grantee Dr. John Blass and his colleagues are doing research on enzyme activity, calcium transport, glucose metabolism and protein synthesis in an effort to reveal the events that precipitate neurotransmitter changes and even cell death in Alzheimer disease. Their search has led them to look at tissues, fluids, and cells outside the brain. Based on their results, they have speculated that Alzheimer disease is a systemic metabolic disease, not simply a neurologic disorder.

For some time, scientists have known that there is a drop in overall glucose metabolism in the brains of Alzheimer patients; in other words, the Alzheimer brain uses less energy. Dr. Blass and his colleagues looked at glucose metabolism in tissues taken from Alzheimer patients and found that there was an inherent abnormality in the cells' ability to break down glucose into energy. They also found a defect in calcium transport at the cellular level.

According to Dr. Blass, Alzheimer disease may be a neurologic disease with systemic manifestations or a systemic disease that shows itself primarily in terms of brain changes. This realization may alter the approach to studies of how the disease develops and how it can be diagnosed and treated.

Alzheimer and Pick Disease: A Common Cause?

Other research continues to alter our understanding of Alzheimer disease. At Harvard University, NIA grantee Dr. Dennis Selkoe has found a surprising similarity between Alzheimer disease and Pick disease, a rare, rapidly progressive dementia.

Alzheimer and Pick diseases have always been presumed to be distinct neurological disorders. Although victims of both diseases suffer disabling dementia, neurofibrillary tangles and neuritic plaques are not found in the brains of individuals who had Pick disease. Only an autopsy can distinguish between the two diseases.

Earlier studies by other investigators had shown that both Alzheimer and Pick diseases affect the same parts of the brain. Research had even speculated that although the lesions of Pick and Alzheimer are different, they might be composed of the same abnormal proteins called paired helical filaments (PHF). Following these leads, Dr. Selkoe used a technique developed in his laboratory to study nerve cells from the brains of Alzheimer and Pick victims. He found that the PHF's once thought to be unique to Alzheimer disease were indeed located in the brain cells of Pick patients.

Dr. Selkoe speculates that Pick disease may be a variant of Alzheimer disease and that the two may share a common cause. This opens up a new field of investigation.

The Aluminum Story

When scientists first looked at the brains of Alzheimer patients, they found excessive levels of aluminum concentrated in dying brain cells. These findings led to fearful speculation by the public that Alzheimer disease could result from ingesting aluminum or using household products containing aluminum. Fortunately, epidemiologists have ruled out such a simple answer to what causes the disease, and our approach to studies of environmental risk factors has become much more sophisticated.

NIA grantee Dr. Bernardino Ghetti has confirmed that when the central nervous system is exposed to aluminum over long periods of time, the result is neurofibrillary degeneration and ultimately cell death. In his work at Indiana University School of Medicine in Indianapolis, Dr. Ghetti is beginning to elucidate the mechanisms by which aluminum causes nerve cell damage. He has found that aluminum binds to the protein calmodulin, impairing its ability to regulate calcium levels in the cell. Calcium is similar in structure to aluminum and is vital to the life of the cell but toxic in large quantities. According to Dr. Ghetti, the key to aluminum's deadly effect on nerve cells may be this breakdown of calcium metabolism at the cellular level.

The Role of Infectious Agents

Since the late 1960's, scientists have been exploring the role of infectious agents in several dementing disorders. Today, some scientists are still looking to see if such an agent might be implicated in Alzheimer disease. Dr. Stanley Prusiner of the University of California at San Francisco—a grantee of the NINCDS and the NIA—first identified the "prion," which causes some infections that reside within the body for years before producing symptoms, as well as a specific protein that is the major component of the prion. Dr. Prusiner's latest research suggests that the prion protein comes from a larger protein present in both normal and infected cells. In normal cells, the larger protein is completely broken down by enzymes; in infected cells, a defective breakdown leaves the prion intact. According to Dr. Prusiner, this prion aggregates to form a fibrous structure that resembles certain filaments found in the brains of Alzheimer patients. Dr. Prusiner is now trying to determine what might happen to change a normal cell into an infected cell and why it appears that the larger protein behaves differently in infected cells than in normal ones.

Related Research

The hypothesis that an infectious agent is the cause of Alzheimer disease is based in part on the known transmissibility of certain other degenerative brain diseases in both humans and animals.

One animal model is scrapie, a slowly progressive neurologic disease of sheep and goats. Scrapie, which can be transmitted to a variety of animal species including mice, hamsters, and mink, is so named because stricken animals repetitively scrape against fence posts and trees. As the disease progresses, the animals degenerate steadily, become paralyzed, and die.

Scrapie infection is characterized by large fibril structures and neuritic plaques in brain tissue, features strikingly similar to pathologic findings in patients with Alzheimer disease. These plaques are found in many chronic diseases, although none has been detected so far in diseases in which viruses have been proven to be the cause.

Purified samples of scrapie-infected tissue have been shown to transmit disease to healthy laboratory animals. Upon close examination, the prion protein has been found to predominate in the infected tissue.

At the National Institute of Allergy and Infectious Diseases (NIAID) intramural Rocky Mountain Laboratories in Hamilton, Montana, Dr. Bruce Chesebro and his colleagues have discovered the genetic material for this prion protein in both healthy and scrapie-infected animals, indicating that the protein is probably a component of normal brain tissue.

Dr. Chesebro examined the brains and other organs of healthy and scrapie-infected mice, using a chemical probe designed to detect the messenger ribonucleic acid (mRNA) sequence that corresponds to the prion protein. Messenger RNA is the molecule that transmits the DNA message to the cell's cytoplasm where it directs protein synthesis. The mRNA sequences were found in tissues of both healthy and infected animals. In no case was the mRNA specific for scrapie-infected tissue.

Dr. Chesebro suggests that prions may simply be part of a healthy cell's structure, and some aspect of the infection causes the protein to bind together to form the deposits found in infected animals. In other words, accumulated protein may be the result of scrapie infection rather than the cause.

Dr. Chesebro's work does not explain the nature of the scrapie agent. His findings do make conceivable the theory that very small virus particles may be responsible for scrapie and other slowly developing diseases.

The Genetic Hypothesis

A discussion of possible causes of Alzheimer disease would not be complete without some reference to genetic studies. In an NINCDS-funded study of 3,500 nursing home residents, Dr. Marshall Folstein at The Johns Hopkins University found evidence of an autosomal dominant pattern of inheritance in certain families with high rates of Alzheimer disease. This could mean that each child of a parent with the familial form of Alzheimer disease has a 50 percent chance of developing the disease in later life.

It seems apparent from our research thus far, however, that the majority of Alzheimer victims don't inherit the disease from their parents. Despite evidence of a familial form of Alzheimer disease, it may be far more common for people to inherit a predisposition to the disease. In an NIA-supported study at the Bronx Veterans Administration Medical Center in New York City, Dr. John Breitner has found that Alzheimer patients are much more likely than those without the disease to have a close relative with dementia.

Both of these studies lend support to the position that genetic factors play a significant role in Alzheimer disease.

Risk Factors in Alzheimer Disease

A team of American and Italian investigators recently reported on the largest case-control study of Alzheimer risk factors, completing a 3-year collaborative effort of the Italian National Research Council and the NINCDS. The findings indicated that people whose brothers or sisters have any form of dementia may be 11 times more likely than others to develop Alzheimer disease. The study also provided some support for earlier observations that severe head trauma may be a risk factor for Alzheimer disease, and that babies born to mothers over age 40 may be at greater risk for dementia later in life.

This study, carried out at seven Italian medical centers under the Science and Technology Agreement between Italy and the United States, did not support risk factors suggested by earlier, smaller case-control studies: family history of Down syndrome, previous thyroid disease, exposure to aluminum or other toxins, allergies, previous surgical procedures, habits of smoking or drinking wine, or certain personality traits. The results did suggest that diagnoses of Alzheimer disease may vary greatly according to the patient's socioeconomic status, probably because mental impairment is more noticeable in people whose education or lifestyle reflects a certain degree of intellectual achievement.

In addition to their work on this project, NINCDS intramural investigator Dr. Bruce Schoenberg and his research team have reported on the occurrence of Alzheimer disease among the 24,000 residents of Copiah County, Mississippi. This landmark study measured the incidence and prevalence of various neurological disorders in a racially mixed population. The results demonstrated that the rate of Alzheimer disease is similar among both blacks and whites. Furthermore, twice as many women as men had Alzheimer disease, and the number of Alzheimer patients increased with advancing age, from 1 percent among people age 40 years and older to 7 percent among those 80 years and older. The range of other estimates of Alzheimer disease indicates that more research in different populations may be needed to establish firmly the incidence of the disease. Nonetheless, this study reconfirmed that aging is one of the major risk factors for Alzheimer disease.

Assessment and Treatment

Several times during the past few years, the media have publicized major improvements in Alzheimer patients given experimental drugs. Each time, a closer examination has revealed that there is still a great deal of work to be done. Scientists now find it necessary to use a variety of tests to evaluate their patients' responses to new drugs, without knowing how reliable the tests results are. A pressing need is for a test that can be used to assess the potential of any drug.

At the Bronx Veterans Administration Medical Center in New York City, NIA grantee Dr. Kenneth Davis has devised a simple test that focuses on the major symptoms of Alzheimer disease and can be used to evaluate patients in all stages of the disease. The test is brief, easy to administer, and can be used anywhere the patient is located. It evaluates such factors as memory, language, mood and behavior; it rates the majority of the items on a five point scale of severity so that subtle changes can be detected.

Dr. Davis and his colleagues originally designed a scale with 40 items. After more than a year of tests, they have pared the list to 21 items they believe are valid and reliable measures of any change in a patient's symptoms of Alzheimer disease.

It is hoped that the Alzheimer Disease Assessment Scale will be sensitive enough to measure the success of any future attempts to treat the disease.

Treatment Approaches

As noted above, patients with Alzheimer disease often have a marked reduction in cells that produce acetylcholine, one of the neurotransmitters that allows nerve fibers to send electrical messages. The loss of these cells may be a cause of some symptoms of the disease. In an effort to increase nerve cell activity associated with acetylcholine, Dr. Richard Mohs and his colleagues at the Mount Sinai School of Medicine in New York City gave 12 patients oral doses of the drug physostigmine, which mimics the action of the neurotransmitter. The tests were conducted in the Mount Sinai General Clinical Research Center (GCRC), one of 78 such centers supported by the National Institutes of Health's Division of Research Resources.

Previous studies at the Mount Sinai GCRC and other medical centers had indicated that intravenous use of the drug temporarily improved the memory of Alzheimer patients. Uniform levels of physostigmine, however, were difficult to maintain due to its short (30-minute) half-life in the bloodstream. Other tests had indicated that a constant level of the drug may be achieved if it is taken orally every 2 hours. The investigators found varying improvements in the memory, sleeping patterns, and behavior of Alzheimer patients during two studies with the drug.

In the first study, designed to find the most effective dose of physostigmine, 10 of the 12 patients significantly improved their scores on the Alzheimer Disease Assessment Scale, the evaluative test described above. But in a followup test that compared a placebo with the physostigmine dose believed to be most effective, only three patients showed significant improvement using physostigmine; four others improved slightly.

According to Dr. Mohs, drugs that increase acetylcholine activity may help some patients with Alzheimer disease, but further research is needed to identify safer, longer-acting drugs.

Conclusion

The National Institute on Aging hopes to continue to expand its research on Alzheimer disease. Studies will focus on analyzing the protein chemistry of normal and abnormal brain structures; developing monoclonal antibodies for specific brain proteins; looking at brain enzymes, particularly those related to oxidative metabolism and neurotransmitter synthesis; and measuring the effects of toxins, infectious agents and genetic factors on brain degeneration. NIA will continue to support research on ways to make an early and accurate diagnosis of Alzheimer disease, and to use improved diagnosis as the basis for establishing multinational epidemiologic studies. Through a cooperative arrangement with NINCDS, NIA will provide cells from definitely diagnosed Alzheimer cases to investigators studying the molecular biology and genetics of the disease. We also hope to expand research on the behavioral and social aspects of the disease, including how families cope under such tremendous stress.

In 1984, the NIA was authorized by the U.S. Congress to establish Alzheimer Disease Research Centers, 10 of which are currently being funded. The most exciting opportunity for future research on Alzheimer disease rests in the potential of these centers to act as a network for sharing new ideas as well as research results. Already, the center directors are communicating about such matters as joint patient registries; shared data, tissue, and brain banks; and standardized diagnostic criteria. The Alzheimer Disease Research Centers share a common goal: to enhance research on the disease by providing the resources and environment for collaborative studies among many scientists from many different disciplines. The long-term reward may be a way to cure and possibly prevent Alzheimer disease. The immediate payoff will be better care for more of its victims.

Alzheimer Disease Research Center Program

The National Institute on Aging currently funds 10 Alzheimer Disease Research Centers (ADRC's) in a program designed to speed us toward an understanding of what causes the disease and what can be done to treat it. Research topics range from studies of the basic mechanisms of Alzheimer disease to those aimed at managing the symptoms and helping families to cope, with each of the 10 centers having its own unique areas of emphasis.

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